SUBSTITUTE SPECIFICATION

MANUFACTURING METHOD FOR POLYMER CHIPS CONTAINING METAL OR METAL OXIDE NANOPARTICLES

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a manufacturing method with respect to polymer chips containing metal or metal oxide nanoparticles. More particularly, the chips are composed of one metal or metal oxide nanomaterial and at least one polymer material, for producing function products, for example, disinfection, antibiosis, far IR and so on.

2. Description of the Related Art

Nanotechnology is the study of nano scale science, that is, technology that is one-billionth of the size of related technology and products. Because of the quantum-size and surface effect, in nano scale, the materials have many amazing physical and chemical properties. These properties are different from bulk material or molecule materials. When materials are shrunk to nanoscale, numerous characteristics are shown and materials serve various functions.

As industry has developed, the weather has also changed. There is a moisture rich environment which multiplies a great quantity of microbes. Any microbe that survives in the environment is a potential pathogen. These microbes could lead to diseases among humans, e.g. staphylococcus induces pneumonia, meningitis and skin infection and demobilized soldier disease bacillus induces demobilized soldier disease.

Since bacteria can do great harm to humans, controlling bacteria growth and protecting the health of humans are important and imperative. Due to science progressing, the antibacterial products are not only to be used for individual health care and for cleaning family appliances, but also for clothing and textiles. The final purpose of antibacterial textiles is to be a protective screen and act as a third layer skin while controlling microbes effectively. This will lead to a comfortable and pleasant life and meanwhile ensure human health.

In current marketing, the antibacterial agent of clothing is categorized in two types: organic systems and inorganic systems. In organic antibacterial agents, the positive charged tetra-amine salts are major components but in inorganic ones, metal ions, e.g. Ag^+, Cu^{2+}, Zn^{2+} etc., are major components.

The antibiosis fabric is manufactured by two methods: using

antibiosis fiber to manufacture various ~~fabrics~~ or fabrics and a textile-finish process (e.g. dipping or coating) ~~by~~ with an antibacterial agent to obtain an antibiosis effect. Comparing both methods, the former has permanent antibiosis effect and washability, but antibiosis fiber is not manufactured easily and consumes more antibacterial agent; the latter is easier to process, but the valid component is on the fiber surface, therefore it will be easier for the antibacterial agent to break away through more washings thereby reducing the deodorization function. There is a big difference in the antibiosis effect of antibiosis materials of metal ions and antibiosis materials containing metal components.

Thus, for a long time, consumers and the inventor hoped for a brand new material of polymer chips containing metal nanoparticles and a manufacturing method thereof. It not only can address the drawback of conventional functionality products by a finish process but can also increase the functionality. The Inventor has devoted himself in studying, development and sales experience on related products for many years. Therefore, the Inventor has developed an improvement by using personal professional knowledge to study and design a manufacturing method of polymer chips containing metal or metal oxide nanoparticles to solve problems mentioned above.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a manufacturing method of polymer chips containing metal or metal oxide nanoparticles to be a raw material for a spinning or plastic process and to be an antibiosis in textiles (fiber, yarn, woven or non-woven) and using the metal or metal oxide nanoparticles to achieve a functional application, e.g. disinfectants, antibiosis, far IR and so on.

It is another object of the present invention to provide a manufacturing method of polymer chips containing metal or metal oxide nanoparticles. The metal or metal oxide nanopacticles are dispersed into polymer materials to form polymer chips and by adding metal or metal oxide nanoparticles to achieve a functional effect, e.g. disinfectants, antibiosis and far IR and so on.

It is yet another object of the present invention to provide a manufacturing method of polymer chips containing metal or metal oxide nanoparticles. The metal or metal oxide nanoparticles are added into polymer materials to form polymer chips. The function of metal or metal oxide nanoparticles atom cluster will not be reduced after washing thereby improving permanency of functionality.

The invention is directed to a manufacturing method of metal or

metal oxide nanoparticles polymer chips. Metal or metal oxide nanoparticles are added into one polymer material to form a well dispersed metal or metal oxide nanoparticles polymer chips whereby the metal or metal oxide nanoparticles become part of textiles or the materials in the plastic process. Furthermore, the products functionality will not be reduced by washing.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings are included to provide a further understanding of the invention, and are incorporated in and constitute a part of this specification. The drawings illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention. In the drawings:

Figure 1 is an illustrate view showing a manufacturing flow of silver nanoparticles polymer chips in accordance with an embodiment of the present invention;

Figure 2 is an illustrate view showing a pressure test of silver nanoparticles polymer chips in accordance with an embodiment of the present invention; and

Figure 3 is an illustrate view showing a SEM image of silver nanoparticles PBT fiber in accordance with an embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Reference will now be made in detail to the preferred embodiments of the present

invention, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers are used in the drawings and the description to refer to the same or like parts.

The conventional technique is to use dipping or coating in the textile-finish process to put an additional functional material onto the textile, thereby helping the problem of a reduced antibacterial effect caused by washing. However, these kinds of processes can not keep the functional material on a textile permanently.

This invention provides an innovative process method for polymer chips. Putting nanometer material into polymer material produces well dispersed nano-polymer chips and nanoparticles which form in part of the textile naturally. Furthermore, functionality is not affected by washing.

The polymer materials of this invention include polyamide, polyester (e.g. PBT, PET, PTT, PPT), polyethylene (PE), polypropylene (PP), polycarbonate (PC), polystyrene (PS), polyacrylonitrile, cellulose, and so on.

There is a wide variety of functional metal or metal oxide nanoparticles and the wide variety used in the antibiosis material in this invention is an example. Multiple metal ions can be produced as metal nanoparticles; examples include Au, Ag, Cu, Zn, Ti, Pd, Pt, Fe, Zr, their oxides, and their composites. Among the metal ions, the inhibitory action of Ag for bacteria is the strongest. Therefore, the use of Ag as an example of metal nanoparticle material is detailed in

this invention. The manufacturing method of silver nanoparticles polymer chips is shown as figure 1. The process flow of polymer chips in accordance to an embodiment of the present invention is illustrated as follows:

Step S12 : mixing 10ml of 1M silver nitrate solution 10ml of 1M citric acid and 980ml of H2O and then disposing at 100° for ten minutes to obtain silver nanoparticles;

Step S14:taking three kilograms of powder of at least one polymer material PBT;

Step S16:blending one liter of silver nanoparticles solution with polymer material and then drying the blended composition; and

Step S18 : extruding the composition via a twin-screw extruder or single-screw extruder to obtain homogenous polymer chips.

The silver nanoparticles polymer chips in accordance with one embodiment of the present invention, can be formed by a spinning process. Before spinning, the polymer chips need to be pressure tested to assure whether further spinning is required or not. The pressure test condition of the polymer chip is one kilogram of well dispersed silver nanoparticles and the polymer chip needs to pass

a filter test, wherein the filter is 400 mesh, speed rate is 100 RPM with a proper temperature (Nylon, PBT:260°C and PET: 280°C).

After the pressure test for the PBT polymer chip, spinning is done if the pressure – ascend – value is smaller than 10 bar/Kg. The spinning step is as follows: Blending the spinning polymer and silver nanoparticles forming polymer chips in accordance to an embodiment of the present invention or using silver nanoparticles polymer chips that are dried and further spinning at 260~290°C by single-screw or twin-screw extruder forming Partially Oriented Yarn(POY) and through a twist process or drawn process to manufacture silver ~~nanoparticles~~ nanoparticle yarn. The process yields silver nanoparticles woven fabric or knit fabric.

The pressure test result of silver nanoparticles polymer chips in this invention is shown as figure 2. In this pressure test figure, vertical axis corresponds to pressure and the horizontal axis corresponds to time. The pressure-ascend-value of the well dispersed silver nanoparticles PBT chips is 5 bar/Kg. This means that the silver nanoparticles PBT chips in this invention are ready for spinning and have great economic value.

The present invention uses scanning electron microscope (SEM) to observe silver nanoparticles distribution of partially-oriented yarn. Figure 3 is a SEM image of PBT fiber containing silver

nanoparticles. The image shows silver nanoparticles uniformly distributed in the PBT fiber. This shows that the present invention provides a good method of uniformly dispersing nanoparticles in a polymer material and manufacturing a stable quality of textiles.

The silver nanoparticles PBT woven fabric and silver nanoparticles knit fabric are produced by a spinning process, twist process or drawn process in present invention. Furthermore, white cottons are antibacterial tested by international standards (JIS L1902-1998 Testing for antibacterial activity and efficacy on textile products). The test germs are golden staphylococcus (ATCC 6538P) and pneumobacillus (ATCC 4352). The test items are: 1.germ culturing concentration; 2. placing the germ solution on an unprocessed white cotton, washing it immediately and calculating_the germ numbers; 3. placing the germ solution on an unprocessed white cotton, culturing for eighteen hours, washing and then calculating germ numbers; 4. after culturing for eighteen hours, washing the test sample (containing silver nanoparticles fiber) and calculating germ numbers. The test data is averaged using a calculated related index, e.g., bacteria growth activity value, bacteriostasis value and disinfection value, thereby judging the antibiosis of the sample. The silver nanoparticles PBT woven fabric and the silver nanoparticles PBT knit

fabric of this invention, have an obvious effect on antibiosis and disinfection. Table I and table II show the antibacterial test result of the silver nanoparticles PBT woven fabric and the silver nanoparticles PBT knit fabric, respectively. In table I, regarding the antibacterial test of golden staphylococcus, the germ culturing concentration of white cotton and the silver nanoparticles PBT woven fabric are 0.72E+5 germ number/ml; regarding the antibacterial test of pneumobacillus, the germ culturing concentration of white cotton and silver nanoparticles PBT woven fabric is 0.72E+5 germ number/ml and 0.75E+5 germ number/ml, respectively. This means the germ culturing concentration of this test details a valid test range. In table I, for the antibacterial test of golden staphylococcus, the bacteriostasis value and disinfection value of white cotton and silver nanoparticles PBT woven fabric is larger than 2.88 and smaller than zero, respectively; for the antibacterial test of pneumobacillus, the bacteriostasis value and disinfection value of white cotton and silver nanoparticles PBT woven fabric is larger than 5.99 and 2.86, respectively.

According to the antibacterial standard of the Japan Association for the Function Evaluation of Textile (JAFET) , the effect of the woven

fabric for golden staphylococcus is not obvious, but for another bacillus, there is obvious bacteriostasis and disinfectant effect. Referring to table II, for the antibacterial test of golden staphylococcus, the bacteriostasis value and disinfection value of the silver nanoparticles PBT knit fabric is larger than 5.8 and 2.99, respectively; for the antibacterial test of pneumobacillus, the bacteriostasis value and disinfection value of the silver nanoparticles PBT knit fabric is larger than 5.57 and 3.09, respectively. Regarding the golden staphylococcus and pneumobacillus, the knit fabric has an obvious bacteriostasis and disinfectant effect.

According to the method mentioned above, this invention produces silver nanoparticles that are uniformly disposed into a polymer material and the manufacturing of a fiber composed of silver nanoparticles which achieves a bacteriostasis and a disinfectant effect.

Table I The antibacterial test result of silver nanoparticles PBT woven fabric

Test Item (JIS L1902-1998 quantify method)		Test result	
		JIS white cotton	containing Silver nano-particles PBT woven fabric
golden staphyloc-occus ATCC 6538P	germ culturing concentration	0.72 E + 5	0.72 E + 5
	Ma	1.44 E + 4	--
	Mb	7.87 E + 6	--
	Mc	--	1.81E +4
	bacteria growth activity value	2.74	--
	bacteriostasis value	--	2.88
	disinfection value	--	<0
Pneumobac-illus	germ culturing concentration	0.72 E + 5	0.75 E + 5

ATCC 4352	Ma	1.43 E + 4	--
	Mb	1.39 E + 7	--
	Mc	--	<20
	bacteria growth activity value	2.99	--
	bacteriostasis value	--	>5.59
	disinfection value	--	2.86

Remark:

1. Ma: placing the germ solution on an unprocessed white cotton, washing it immediately and then calculating germ numbers.
2. Mb: placing the germ solution on an unprocessed white cotton, culturing for eighteen hours, washing and then calculating the germ numbers.
3. Mc: the test sample (containing silver nanoparticles fiber).
4. Bacteria growth activity value is equal to log (Mb/Ma) .Bacteria growth activity value is lager than 1.5, that means the experiment is effective.
5. Bacteriostasis value is equal to log (Mb/Mc) .
6. Disinfection value is equal to log (Ma/Mc) .

Table II The antibacterial test result of silver nanoparticles PBT knit fabric

Test Item (JIS L1902-1998 quantify method)		Test result	
		JIS White cotton	containing silver nanoparticles PBT knit fabric
golden staphylococc-us ATCC 6538P	germ culturing concentration	0.99 E + 5	0.99 E + 5
	Ma	1.97 E + 4	--
	Mb	1.25 E + 7	--
	Mc	--	<20
	Bacteria growth activity value	2.80	--
	bacteriostasis value	--	>5.80

	disinfection value	--	>2.99
pneumobacillus ATCC 4352	germ culturing concentration	1.24 E + 5	0.75 E + 5
	Ma	2.49 E + 4	--
	Mb	7.47 E + 6	--
	Mc	--	<20
	bacteria growth activity value	2.48	--
	bacteriostasis value	--	>5.57
	disinfection value	--	>3.09

Remark:

1.Ma: placing the germ solution on an unprocessed white cotton, washing it immediately and then calculating germ numbers.

2.Mb: placing the germ solution on an unprocessed white cotton, culturing for eighteen hours, washing and then calculating the germ numbers.

3.Mc: the test sample (containing silver nanoparticlesfiber).

4. Bacteria growth activity value is equal to log (Mb/Ma) .Bacteria growth activity value is lager than 1.5, that means the experiment is effective.

5. Bacteriostasis value is equal to log (Mb/Mc) .

6. Disinfection value is equal to log (Ma/Mc) .

In this invention, the method comprises using one metal or metal oxide nanoparticles material and at least one polymer material, blending and extruding to form polymer chips. The metal or metal oxide nanoparticles are dispersed into polymer chips and by spinning, textile process they are used as antibiosis textiles or plastic process materials. In this invention, we try to replace the conventional technique that the functional textiles need to be manufactured by a finished process. Furthermore, the invention uses metal or metal oxide nanoparticles to replace metal ions thereby achieving a functional effect because metal ions easily lose functionality by washing. And in accordance to an embodiment of the present invention, the fabric with metal atom cluster does not have the same antibiosis properties as the fabric with metal ions. Metal ions

need to reach a critical concentration before there is a bacteriostatic effect. After washing, the concentration of metal ions is not enough and the bacteriostatic effect will be lost. Furthermore, if the concentration of metal ions is higher it will irritate consumers, e.g. Ag ion and Cl ion produce AgCl. As long as the fabric has a disinfectant function, the numbers of metal cluster will not affect the bacteriostatic effect.

The method mentioned above shows the purpose and efficacy of this invention as well as the value in industry. Meanwhile, it is a new and hither to unknown invention in current market.

In accordance with the above mentioned; the foregoing is considered as only illustrative of the principles of the invention. Furthermore, since numerous modifications and changes will readily occur to those skilled in the art, the invention is not limited to the exact construction and operation as shown and described, and accordingly, all suitable modifications and equivalents may be resorted to, falling within the scope of the invention.